Colorado River Native Fishes and Introduced Sportfish: Immiscible or Emulsion?

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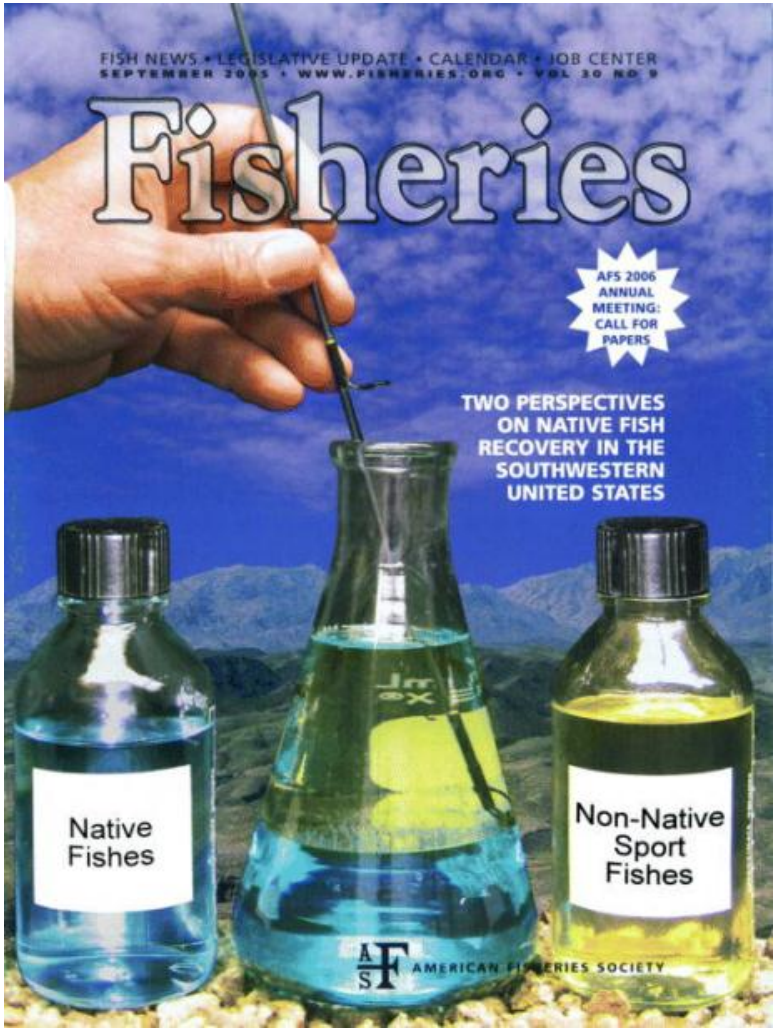
Immiscibility of native and nonnative fishes



Immiscibility of Native and Non-native Fishes, 2005

PAUL C. MARSH AND CAROL A. PACEY, *Fisheries*

Conflicts between Native Fish and Nonnative Sport Fish Management in the Southwestern United States, 2005

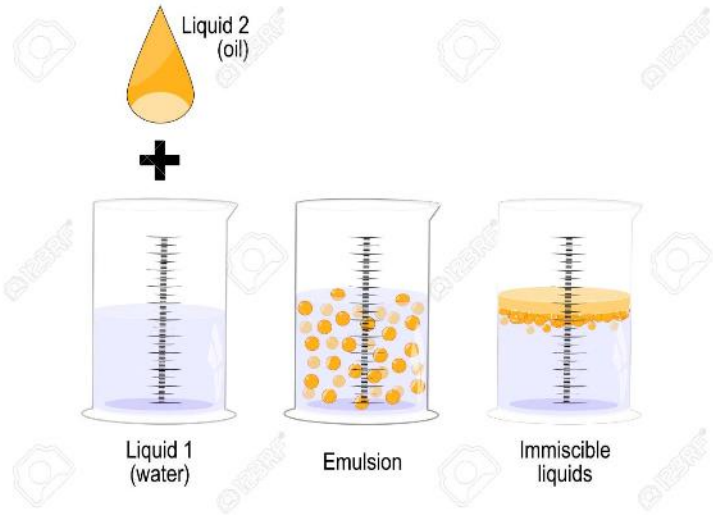
Robert W. Clarkson a , Paul C. Marsh , Sally E. Stefferud & Jerome A. Stefferud, *Fisheries*

Predatory Fish Removal and Native Fish Recovery in the Colorado River Mainstem, 2005

Gordon A. Mueller, ,*Fisheries*

Emulsion - stable mixture of one immiscible fluid within another, made possible by an emulsifier

Emulsifiers form physical barriers between fluids



99% of the time – Immiscible

In a few rare instances native fish persist even in the presence of non-coevolved predators

What is the “Emulsifier?”

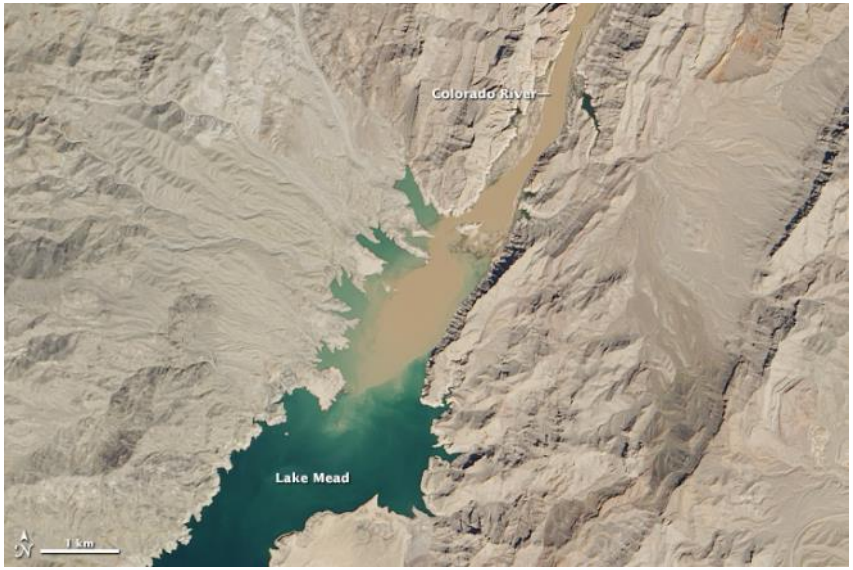
Hypothesis:

Turbidity can “emulsify” native fish/sportfish interactions

Little Colorado River

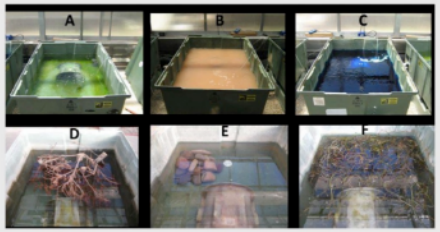
Colorado River inflow to Lake Powell

Colorado River inflow to Lake Mead



What Environmental Conditions Reduce Predation Vulnerability for Juvenile Colorado River Native Fishes?

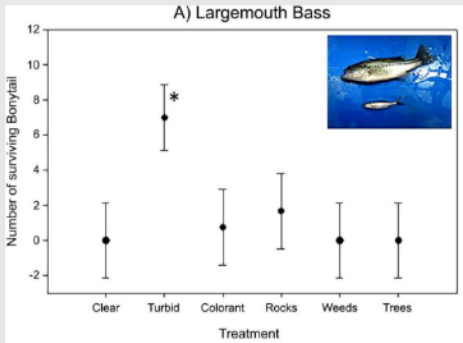
David Ward, and Ben Vaage,
USGS, Southwest Biological Science Center, Flagstaff, AZ

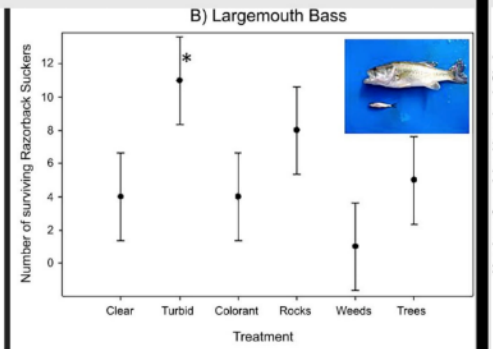


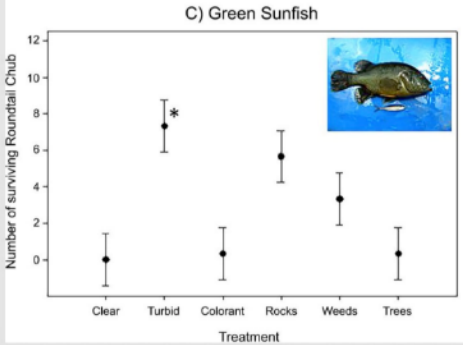
Six treatments used to evaluate the effects of environmental characteristics on vulnerability of native fish to introduced warm-water predators. Treatments included (A) control tank, (B) turbidity (500 NTU), (C) blue commercial pond colorant, (D) woody debris, (E) rocks, and (F) floating aquatic vegetation

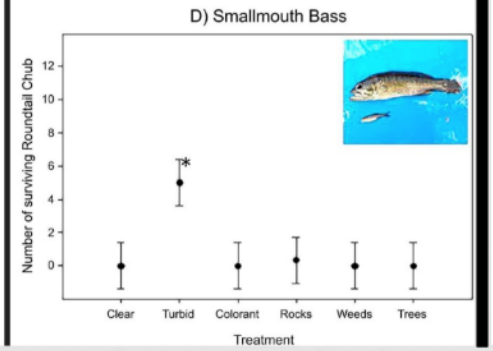
Satellite image of the Colorado River inflow into Lake Mead (March 2013) with typical high turbidity. This is the type of environment in which juvenile Razorback Suckers have recently been found to survive and recruit despite the presence of abundant Introduced predators

Sight-feeding predators

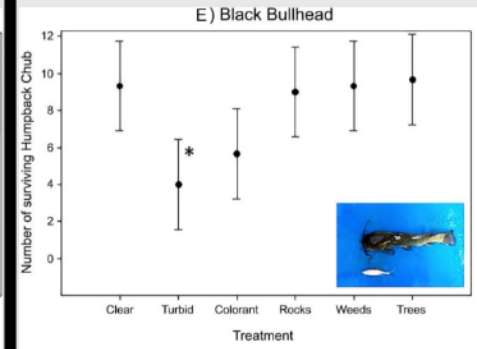


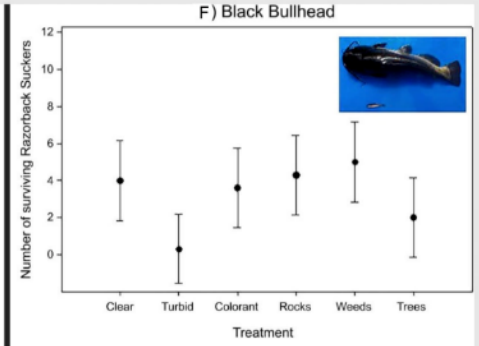


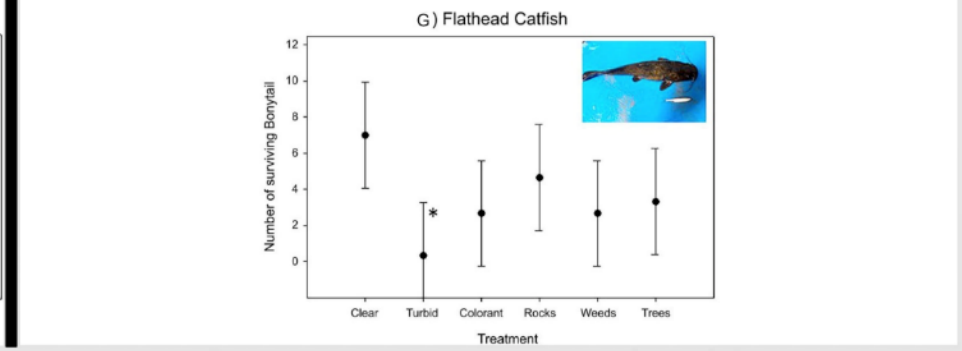




Non Sight-feeding predators







Number of juvenile native fish (Bonytail, Humpack Chub, and Razorback Sucker) that survived predation by sight-feeding predators to include Largemouth Bass (A and B), Green Sunfish (C), Smallmouth bass(D), Black bullhead (E and F), and Flathead Catfish (G), during 24-h laboratory predation trials under six different environmental conditions (clear = control). Each point is the mean of three replicate trials. Error bars represent 95% confidence intervals. Asterisks denote statistically significant differences.

Turbidity reduces predation vulnerability to sight feeding predators

Turbidity increases predation vulnerability to non-sight feeding predators

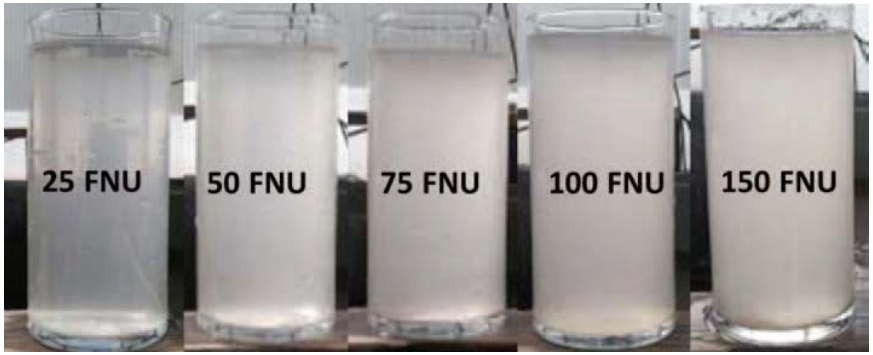
Its not just turbidity alone

- What is the specific native fish?

- What predator species are present?

Ward and Figiel 2013, *Journal of Fish and Wildlife Management*

Reduced movement makes sense In the historic Colorado river



USGS

Differences in behavioral response

- Chub move away from threats

- Razorback suckers avoid movement

?

USGS

Turbidity shaped the predator avoidance behavior of Razorback Sucker

for 3 million years

Conservation of imperiled native fishes requires an understanding of the ecological and evolutionary processes that have shaped predator-prey interactions and how those interactions are mediated by specific features of habitat.

To be effective, management of native fishes must include elements of maintaining or enhancing features of habitat that reduce predation vulnerability

(Matter and Mannan 2005, How do prey persist, *The Journal of Wildlife Management 69: 1315-1320*).

For RZ = Turbidity

The catfish conundrum!!

- Turbidity solves the predation problem for – for sight feeding predators

- Turbidity increases predation effectiveness of catfish

» RZ suckers and catfish are Immiscible !

Nothing even similar to a Catfish in the historic Colorado River

Prior to Glen Canyon Dam

Most abundant fish in the Colorado River

(Dill 1944 surveys)

Short Term-

Focus work in areas
With naturally high turbidity –

Limited areas within the
Colorado River system

Could we create turbid areas within the system with turbidity curtains and bentonite clay?

Example: Create a Predator-free environments for Rearing Razorback Sucker within Lake Mohave or Mead

Ideas for how this could work

- Close the curtain post RZ spawn over a spawning area
- Manipulate turbidity inside the curtain to disadvantage all the sight feeding predators present
- Remove catfish inside the curtain
- Rear fish for a year
- Net and tag fish inside curtain
- Remove curtain - Soft release/turbidity acclimated fish

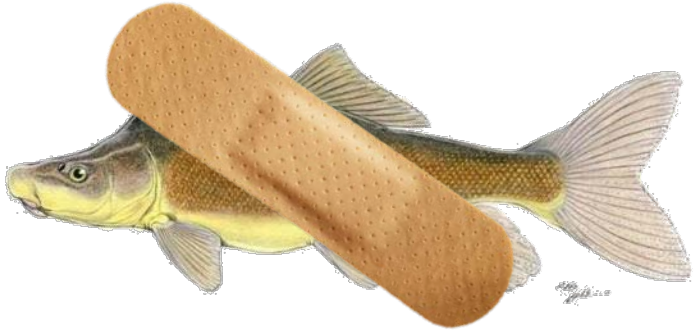
Advantages

- Don’t have to net and transport larvae
- Natural rearing conditions
- Thermally connected to the lake
  - Better mid-summer water quality than golf course ponds or isolated backwaters

Long Term-

Look more broadly for other areas with naturally high Turbidity, adequate thermal regimes and no catfish

No political will



Preserve Genetics

Indecision as a Rational Choice

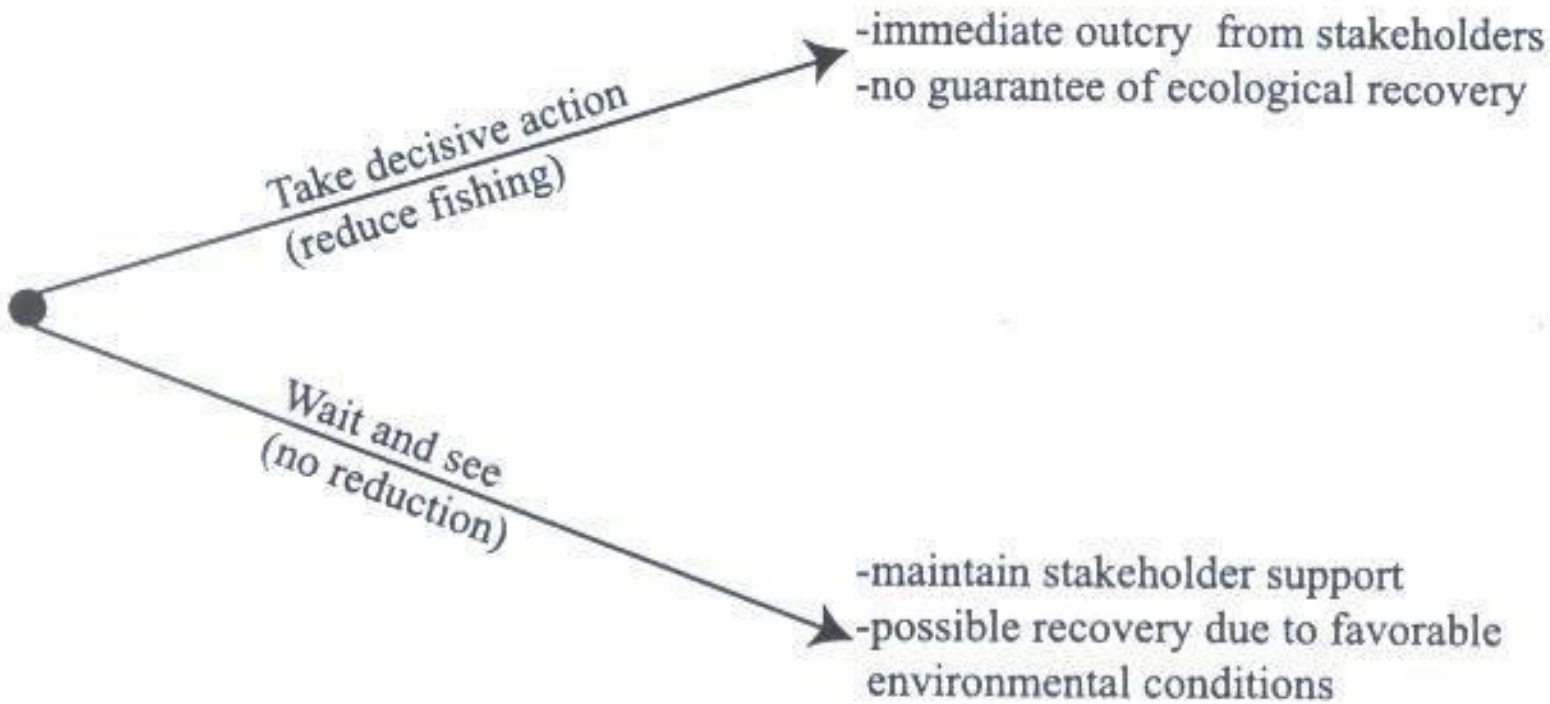


FIGURE 1.1: Indecision as a rational choice during a fishery decline. Viewed from a fishery manager's perspective in terms of a simple decision tree, it can be fully rational for the manager faced with either certain outcry from fishing stakeholders if decisive action is taken, or the possibility that nature will correct the situation without intervention even if no action is taken, to gamble on the situation's correcting itself (i.e., to be deliberately indecisive).

Walters and Martel 2004, Fisheries Management and Ecology

A fundamental problem with the way Mitigation programs for Colorado River Native fish are structured

1. Because Indecision becomes a rational choice - tight restrictions on how and where mitigation $ can be spent
   - When there is no public or political will for big changes – then limited options for conservation
2. Long-term/locked in – Little incentive to renegotiate terms with learning

“The success of traditional hatchery programs is typically measured by the number of fish stocked, but hatchery programs for endangered species must measure success in terms of long-term survival and species recovery”

(Anders 1998, Brannon 1993)